United States Department of Agriculture
Agricultural Research Service

EASTERN REGIONAL RESEARCH CENTER FACT SHEET

Improving Food Safety Through a Better Understanding of Bacterial Responses to Environmental Factors

Program Background

Food and agriculture systems expose pathogenic bacteria to heat, cold, salt, acid, oxidative, and other stresses that provoke bacterial responses designed to cope with the particular stress situation. Bacteria possess mechanisms to adapt to sublethal stresses, rendering them resistant to lethal levels of the same stress and/or resulting in the capacity to withstand other types of stresses. This is important because stress-adapted bacteria may be more difficult to inactivate with techniques commonly used by the food industry. Stresses used in food systems to control bacterial growth may, in fact, increase the disease-causing (virulence) potential of pathogens that survive the particular treatment. In addition, surface structures such as “curli”, which are involved in biofilm formation, are controlled by environmental signals. Using genomics (study of genes) and proteomics (study of proteins) tools, we are investigating the regulatory networks that allow pathogens to survive despite the growth barriers placed in foods and during food processing.

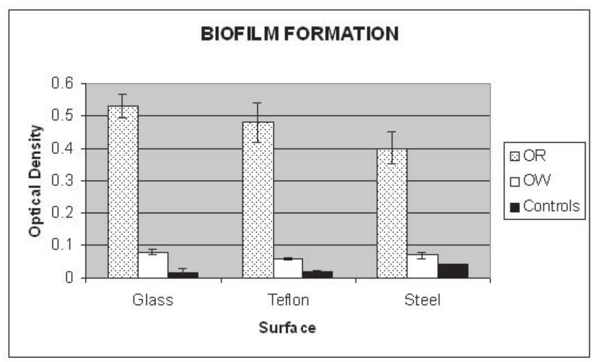
Quorum sensing is a phenomenon through which small signaling molecules termed autoinducers are employed for bacterial cell-to cell communication in response to population density and environmental stresses. Studies have shown that quorum sensing is widespread and involves complex interconnected regulatory networks that serve to fine tune the expression of diverse behaviors, including sporulation, virulence, and biofilm formation. The research focuses on elucidating how conditions in food environments initiate quorum sensing responses, which then modulate pathogen behavior in favor of survival.

In addition, genomics/proteomics approaches are being used for molecular characterization of pathogens to determine their virulence potential, and will provide information for the identification of molecular markers for identification and typing of pathogens. These research approaches provide fundamental information for the development of novel intervention strategies and tools for identification of food-borne pathogens.

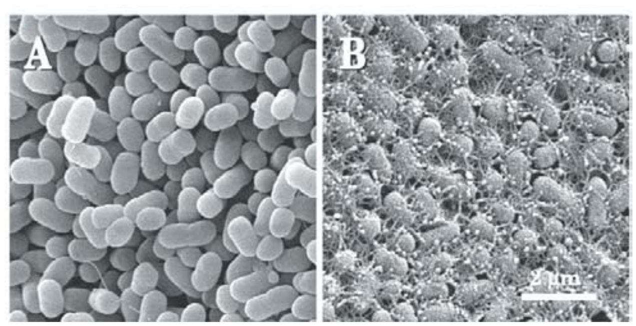
Research Objectives

Over the next five year period, the research program will focus on the following specific objectives:

- Investigating the mechanisms for pathogen adaptation in foods to determine what conditions affect survival, resistance, and pathogenicity.
- Investigating bacterial cell-to-cell signaling mechanisms (quorum sensing) and their role in growth, survival, biofilm formation, and pathogenicity in foods.
- Developing and utilizing genetic-based methods for identification, typing, and characterization of food-borne pathogens and food safety threats.

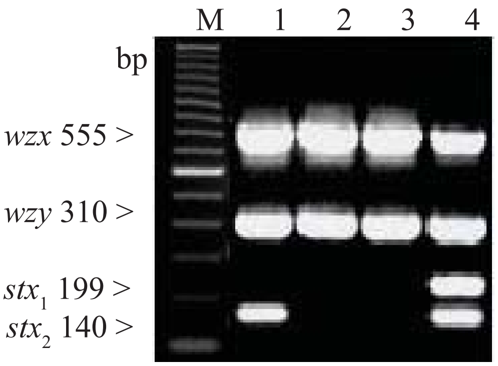


Biofilm formation of *E. coli* O157:H7 strains 43895OR (OR; curli-producing) and 43895OW (OW; non-curli-producing) on glass, Teflon, and stainless steel surfaces.



Topographical images of colonies of *E. coli* O157:H7 strains (A) 43895OW (curli non-producing) and (B) 43895OR (curli producing) grown on agar for 48 h at 28ºC.

For additional information contact Pina Fratamico
pfratamico@errc.ars.usda.gov; tel: (215) 233-6525



Agarose gel showing results of a multiplex polymerase chain reaction (PCR) assay targeting the *E. coli* O145 *wzx* and *wzy* genes (found in the *E. coli* O145 O antigen gene cluster) and the Shiga toxin genes. All 4 strains were positive for *wzx* and *wzy*, in addition to the Shiga toxin 2 (lane 1) or Shiga toxin 1 and 2 genes (lane 4).
M, molecular weight standards.

Principal Investigators

Chin-Yi Chen, Ph.D.
Molecular Biologist
tel. 215-233-6526
fax. 215-233-6581
cchen@errc.ars.usda.gov

Pina M. Fratamico, Ph.D.
Microbiologist/Lead Scientist
tel. 215-233-6525
fax. 215-233-6581
pfratamico@errc.ars.usda.gov

Nereus “Jack” Gunther, Ph.D.
Molecular Biologist
tel. 215-233-6503
fax. 215-233-6581
ngunther@errc.ars.usda.gov

Gaylen Uhlich, Ph.D.
Molecular Biologist
tel. 215-233-6740
fax. 215-233-6581
guhlich@errc.ars.usda.gov

Emeritus Scientist

James L. Smith, Ph.D.
Emeritus Scientist
tel. 215-233-6520
fax. 215-233-6581
jsmith@errc.ars.usda.gov

Impact

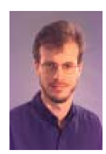
Firstly, the research on bacterial stress responses provides information on the effects of food environments and food processing and storage conditions on growth and survival of pathogenic bacteria that is necessary for the development of strategies to decrease viability of pathogens in foods.

Secondly, the research on quorum sensing will assist in understanding how biofilms are formed. It also provides information on the types and levels of cell-to-cell signaling molecules produced by food-borne pathogens under different conditions and on bacterial processes that are modulated by these signals. Control strategies that modulate production or that inactivate signaling molecules may offer a means to control the growth of undesirable bacteria in food.

Finally, new approaches and tools to type and characterize emerging pathogens, including new serogroups of *E. coli* associated with diarrheal illness, non-*jejuni*/*coli* species of *Campylobacter*, and antibiotic resistant organisms are essential for identification and control of new threats, including agents that may be employed for bioterrorism.

Project Personnel

Lori K. Bagi
Microbiologist
tel. 215-233-6624
fax. 215-233-6581
lbagi@errc.ars.usda.gov



Bryan Cottrell
Biological Science Laboratory Tech
tel. 215-836-3751
fax. 215-233-6581
bcottrell@errc.ars.usda.gov

Terrence P. Strobaugh
Biological Science Laboratory Tech
tel. 215-233-6455
fax. 215-233-6581
tstrobaugh@errc.ars.usda.gov